

**PROPOSED**  
**Feral Hog Management Plan**



**Havasas National Wildlife Refuge**

United States Department of Interior  
Fish and Wildlife Service  
Region 2

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## PROPOSED FERAL HOG MANAGEMENT PLAN

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## I. INTRODUCTION

### 1.1 Area Description

Havasas National Wildlife Refuge (NWR) encompasses 37, 515 acres adjacent to the Colorado River. Topock Marsh, Topock Gorge, and the Havasu Wilderness comprise the three major units of the Refuge. The habitat varies from thick cattail/bullrush stands and mixed riparian vegetation found along the Colorado River and Topock Marsh, to steep cactus-strewn cliffs and mountains found along Topock Gorge and Havasu Wilderness (USFWS).

This Refuge was established by *Executive Order 8647* on January 22, 1941, .....as a Refuge and breeding ground for migratory birds and other wildlife . Over 300 species of birds, 42 species of mammals and 38 species of reptiles and amphibians have been recorded at Havasu NWR (USFWS 1994). Federally listed endangered species associated with Havasu NWR include two birds, the Yuma clapper rail and the Southwestern willow flycatcher, two Colorado River native fishes, the Razorback sucker, and the Bonytail chub, and one reptile, the Mohave desert tortoise (USFWS 1994). The Refuge is also within the range of the lowland leopard frog, which is Federally listed as a candidate species. Current management practices on the Refuge are directed at the conservation of wildlife resources to assure the preservation of native plants and animals, especially those threatened with extinction (USFWS 1999).

The following is excerpted from the *Preliminary Hydrologic Investigation of Topock Marsh Arizona* (-Brad Guay Ph.D. Candidate 1998):

The climate is semiarid to arid, with a 50 year (Needles airport) average annual air temperature between 115-125 degrees Fahrenheit and precipitation of 4.5 inches (WRCC 1997). Located on the Pacific Flyway, and flanked by hostile deserts, the marsh must appear as a carrier deck for passing birds. With respect to the lower Colorado River Basin (LCRB), or more specifically, between upper lake Mead and Mexico, the acreage of surface water is estimated by the USBR (1996) as follows: (1) reservoirs- 212,600 ac, (2) flowing river- 18,700, and (3) backwater- 10,200 ac. Of these backwater areas, which offers some of the best habitat and foraging areas for waterfowl, Topock Marsh comprises 4, 045 acres, or roughly 40 percent.

The marsh receives Colorado River water through two east-flowing diversion canals. Water not lost to evaporation or seepage is released through a control structure on the south dike where it eventually reenters the river. Within the marsh boundary there are 1291 acres of emergent vegetation (sparse and dense areas included) and 151 acres of terrestrial land areas.

The target area for this Feral Hog Management Plan encompasses the 15,000 acre Topock Marsh Unit (see Figure 1.). This unit is bounded by Interstate 40 to the south, the Fort Mojave Indian Reservation and Bureau of Land Management administered lands to the North, and the Colorado

River to the West (Figure 1). If feral hog control measures are successful around the marsh, they will then be employed and extended down the river corridor through the Topock Gorge unit.

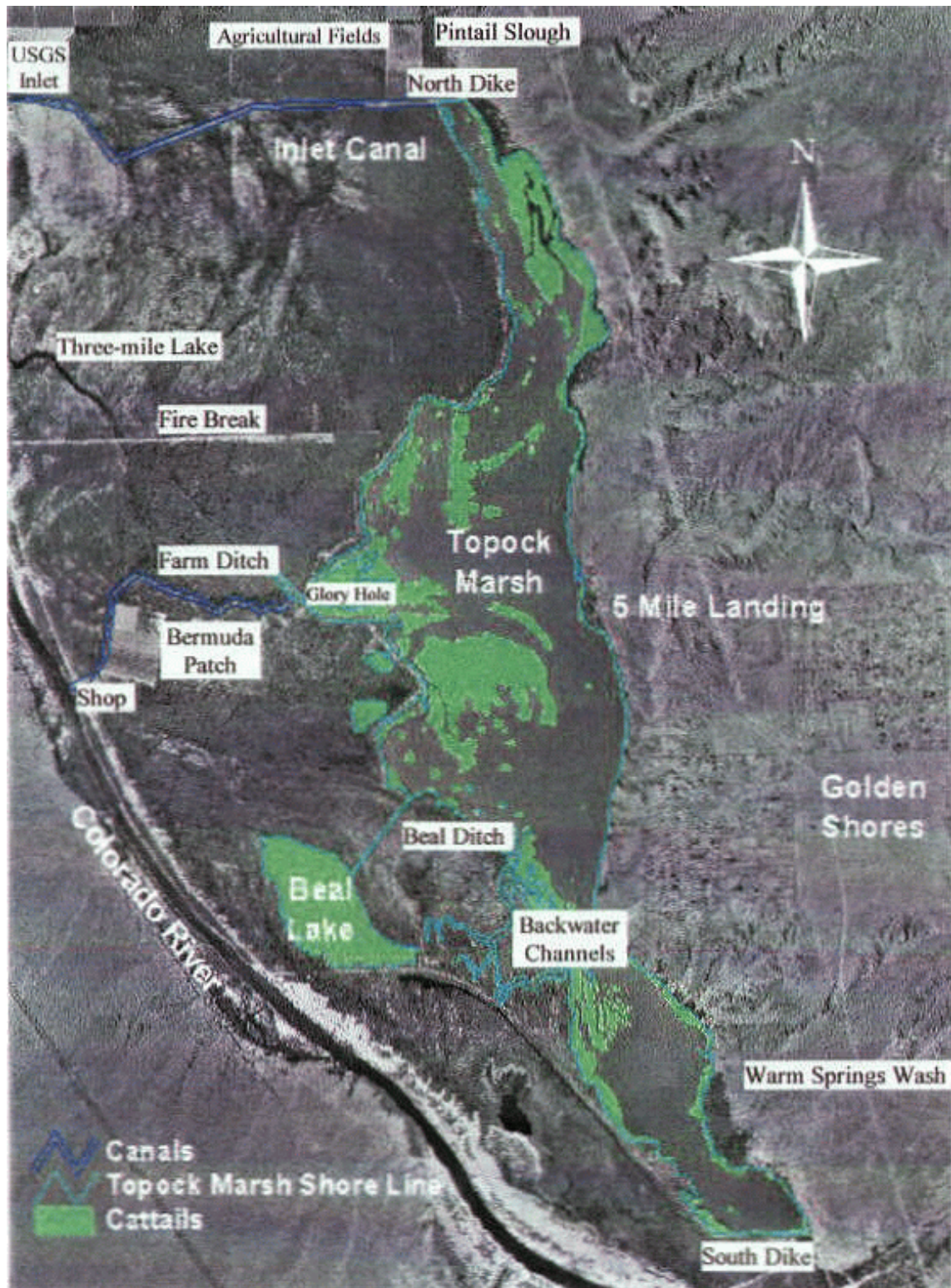


Figure 1. Landsat image of Topock Marsh.

## 1.2 *Land Use*

The lands now encompassed by the Refuge have historically been occupied by the complex societies of the Mojave people that once occupied the lands surrounding the Lower Colorado River at the time of Spanish entry. Currently, evidence of their habitation/village sites are non-existent. Annual flooding of the river and development of Parker Dam resulted in the destruction of evidence of their long-term habitation (USFWS 1994). Rock art sites called petroglyphs, ground images known as geoglyphs, rock alignments and clearings, dance patterns, cairns, trails, sparse scatters of lithic material, and pottery shards are all that remain of the societies that occupied this area for thousands of years (USFWS 1994).

Prior to its establishment as a National Wildlife Refuge, the area now known as the 15,000 acre Topock Marsh unit was just a seasonally flooded backwater of the Colorado River. Recreational uses of the area were limited as access was difficult.

Since its establishment in 1941, Havasu NWR has become a haven for both wildlife and people alike. Each year thousands of people launch their boats to explore the beauty found at the Topock Gorge unit of Havasu NWR. Topock Marsh is a favorite area for fishing, waterfowl hunting, dove and quail hunting, kayaking, and canoeing.

## 1.3 *Background Summary*

Little is known about the introduction of feral hogs on Havasu NWR. It is believed they originated from domestic stock that belonged to the Soto Ranch located north of Needles, CA. Extensive flooding of the Colorado River is assumed to be the primary reason for a large dispersement of the swine. Reports of feral swine on the marsh lands go back further than 1900 (Havasus 1975).

The 1975 estimated feral hog population on Havasu NWR was between 300 and 400 individuals. Currently, there are frequent sightings of feral hogs by Refuge staff and other visitors. Considering that hogs can potentially double their population in four months if given adequate food resources, the current number of hogs now on the Refuge could be quadruple the 1975 estimate. During the spring and fall months, sows are often observed with as many as 13 piglets (Havasus 1975). Several researchers report frequent sightings of feral hogs feeding and wallowing along the edges of the marsh within the cattail or bulrush stands during the hot summer months.

## 1.4 *Past Feral Hog Management Strategies*

The first organized attempt to control the feral hogs on the Refuge was in 1971 when 1.5 miles of fencing was installed around the 100 acre Topock farm area to prevent further hog damage to croplands, irrigation ditches and levees (USFWS 1979). The second organized attempt was a controlled public hunt in March of 1975. This attempt resulted in a low hunter success rate and



high administrative costs, as only 42 hogs were taken out of the 175 hunters recruited (USFWS 1979). In 1979, an additional 4 miles of hog proof fencing were installed in the Pintail Slough Farm Area. Unfortunately, the fences were not maintained and are in need of repair. The feral hogs are presently able to roam in and out of the fenced areas. Control methods since that time have consisted of opportunistic shooting by Refuge personnel. This method remained unchanged until January of 2000 when the Biological Technician was prompted to conduct literature searches to solicit information regarding the best control methods currently being utilized for feral hogs. Inquiries were made to other U.S. Fish and Wildlife Service (USFWS) Refuges as well as Military Installations with established feral hog populations. The result was construction of a portable box trap with a drop gate, constructed by both the Refuge Biologist and volunteer Biological Technician. Unfortunately, the trap proved ineffective due to lack of suitable bait to lure the feral hogs.

The next control effort utilized by both the Refuge Biologist and Biological Technician involved the use of feral hog snares. This method also proved ineffective as the snare cables had to be replaced after every capture, and the feral hogs were replacing themselves quicker than they could be caught. It soon became obvious that if complete eradication of feral hogs was the goal, outside assistance was imperative.

### 1.5 *Purpose and Need*

Feral hogs are nuisance species that have been hindering the management practices on the Refuge. These practices are directed toward the conservation of wildlife resources to assure the preservation of native plants and animals, especially those threatened with extinction. Of utmost concern is the constant threat the feral hogs pose to the fragile desert ecosystem, as well as the threatened and endangered wildlife found on the Refuge. In addition, feral hogs have been inflicting damage to waterfowl food production areas, irrigation ditches, and levees. The development and implementation of an effective and humane plan to remove this exotic pest is essential to achieving our goal of conserving and preserving native wildlife.

Although organized attempts at managing the Refuge's feral hog population have been ongoing since 1971, no formal written strategies have been developed as guidelines for the future. The intent of this plan is to provide revisable guidelines and strategies for an integrated approach to managing and monitoring the feral hog population at Havasu National Wildlife Refuge.

## **II BIOLOGICAL CHARACTERISTICS**

### 2.1 *Description*

The feral hogs presently found in the US belong to two groups- hogs that are descendent of domestic stock (feral hogs) that were released, abandoned, or escaped and hogs descendent from

wild stock (Russian boar) introduced for hunting purposes (Bratton). It is believed that the Havasu population grew from domestic stock as stated in the previous section.

Although feral hogs look similar to domestic swine, they quickly begin to evolve characteristics of wild swine that include: elongation of the snout, lengthening of the hair, loss of the curl in the tail, four continually growing tusks found on boars, as well as development of a thick, tough skin composed of cartilage and scar tissue (USDA 2000 and Stevens 1996). In addition, feral hogs can reach 3 feet in length and 300-400 pounds in weight.

## *2.2 Distribution of feral hogs at Havasu NWR*

The majority of the feral hog population is concentrated in the 15,927 acre Topock Marsh Unit. This unit embraces all of the Refuge north of Interstate 40, with the Colorado River forming the western boundary. The heart of this unit is an impounded 4,000 acre marsh, a network of open water bays, ponds, and channels laced by vast cattail and bulrush stands. Flooded stands of trees within the marsh offer valuable habitat for a wide range of avian species including several endangered species (USFWS 1999).

It was formerly believed that the feral hog population was restricted to only the Topock Marsh Unit due to human habitation and development. However, occasional sightings of feral hogs began in 1994 at the Topock Gorge Unit of the Refuge. These hogs most likely came from Crystal Beach, a rural community adjacent to the 1994 sightings. Currently, encounters of feral hogs in this area are commonplace.

## *2.3 Reproduction*

Feral hogs are the most prolific large mammal in North America and given adequate nutrition, can double their population in four months (Barrett and Birmingham 1994). Sows normally begin breeding at six months of age and have an average of two litters per year with 5-13 piglets per litter (USDA 2000). Here at Havasu NWR, the feral hog breeding season is year long as sows with their piglets are observed year round.

## *2.4 Home Range and Activity Period*

Feral hog home ranges can vary from 0.4-19 square miles depending on availability of food and water (Stevens 1996). At the Topock Marsh Unit, it is believed that the home ranges of feral hogs are larger during the fall and winter, and smaller during the late spring and summer months due to the extreme summer temperatures. Males have larger home ranges than females, especially during the breeding season (Stevens 1996). Unless accompanied by a receptive sow, boars are generally solitary when traveling and feeding. Groups of hogs normally seen throughout the Refuge consist of sows and their young.

## 2.5 *Habitat*

Feral hogs have demonstrated that they can adapt to just about any habitat type and are reported to have established populations in 23 states across the US ( Miller 1993, Jones et. al 1997). They seem to prefer moist bottomland, and are probably most common along riparian areas with dense vegetation (Stevens 1996). Feral hogs at the Topock Marsh Unit of Havasu NWR are most commonly observed feeding in the emergent vegetation surrounding the marsh and traversing along their extensive network of trails.

## 2.6 *Food Habits/Competition*

Feral hogs are considered to be opportunistic omnivores (Stevens 1996). Along with a diet high in vegetative matter, portions of birds, eggs, small mammals, fawns, piglets, frogs, snakes, lizards, salamanders, turtles, and insects have all been found in feral hog stomachs along with a large number of invertebrates (Wood and Barrett 1979). With their keen sense of smell, feral hogs are considered to be formidable predators. Calves, kids, lambs, fawns, and ground nesting birds have been known to become prey of feral hogs (Stevens 1996). Although the feral hogs at Havasu NWR seem to eat just about anything, the season or time of year determines the bulk of their diet. Spring diets here on the Refuge include grasses, forbes, roots and tubers. During the late summer / fall, their diet seems to shift to one high in mesquite beans. Of concern is the documentation of potential competition for food with deer, turkey, waterfowl, squirrels, raccoons, opossums, foxes, bobcats, javelinas, bears, sandhill cranes, coyotes and chipmunks (Stevens 1996). Although several of these species are not present at Havasu NWR, this list was provided to emphasize the diverse diet of feral hogs, and the extent in the number of species affected by their presence.

## 2.7 *Damage and Environmental Concern*

Rooting, trampling, consumption, accelerated erosion and predation are among the documented impacts of feral hogs in the US (Stemer and Barrett 1991). Rooting, if severe enough, could potentially alter plant community successional sequences to include soil erosion, consumption of native seed crops, consumption of threatened and endangered species, altered plant succession in monocultures or native rangeland and reduction of overall species diversity (Stevens 1996). At Havasu NWR, the rooting behavior causes accelerated erosion of the desert landscape and disturbs the natural patterns of vegetative succession by promoting the growth of undesirable, invasive vegetation such as Salt Cedar and Russian Thistle.

Concern about the susceptibility of wetlands to feral hog damage is great, due to the nature of the sensitive habitat. During the warm summer months, hogs frequently wallow and root around in shallow wetlands resulting in erosion that might impact water quality and disrupt the sensitive plant community (Barrett 1982, USDA). At Havasu NWR, this behavior coincides with the Yuma clapper rail nesting season. Feral hogs are known to feed on ground-nesting birds, and their rooting activity has the potential to destroy nests and reduce the overhead cover needed for

these federally endangered birds to avoid nest predation. Furthermore, the destructive wallowing behavior of hogs in shallow watering holes and ponds consequently could lead to fouled water supplies caused from muddying water, algal blooms, bank erosion, and the destruction of aquatic vegetation leading to the alteration of riparian habitat (Stevens 1996). This behavior could potentially affect the permanent population of endangered Razorback suckers established in the Beal Lake area of the Refuge.

Feral hogs are notorious for inflicting crop damage and are almost always found in association with Refuge croplands (Laguna Atascosa NWR). At Havasu NWR, damage to waterfowl food production areas, irrigation ditches, and levees has been a problem for a number of years. Approximately 1 1/2 miles of hog-proof fence was constructed around the 100 acre Topock Farm field in 1971. An additional 4 miles of fence was constructed along the Pintail slough waterfowl food production area in 1979 (USFWS 1979). By 1986 the fences had become dilapidated and hogs were, once again, frequently seen in these areas.

## 2.8 Disease

Feral hogs serve as disease reservoirs (USFWS) and pose a threat to the health of both humans and other animals. They are known to carry 13 diseases, including brucellosis, pseudo rabies, tuberculosis, bubonic plague and anthrax (Burns and Loven 1998). The two diseases of most concern are pseudo rabies and swine brucellosis.

Pseudo rabies is not related to the rabies virus and cannot infect humans (USDA, Stevens 1996). It is a viral disease and affects the nervous system. It can be transmitted and carried by both domestic and feral hogs and can be fatal to cattle, horses, goats, sheep, dogs, cats, raccoons, skunk, opossum and small rodents (USDA). Once hogs become infected they are carriers for life.

Swine brucellosis causes infertility and is transmitted through reproductive discharges such as semen or afterbirth (Stevens 1996). To date, the only method of control involves testing and removal of infected individuals in the population, a method not feasible in wild populations. This disease could be transmitted to humans, and can be expressed by flu-like symptoms, arthritis, and meningitis (USDA). Humans can be treated with antibiotics, but there is no cure for other animals.

## III POLICIES AND REGULATIONS GOVERNING FERAL HOG CONTROL

The following is excerpted from the *Lower Rio Grande Valley NWR Complex EA* and applies directly to the contents of this Feral Hog Management Plan:

The policy of the U.S. Fish and Wildlife Service (Service) is to engage in the control of wildlife within the National Wildlife Refuge System to assure balanced wildlife and fish populations consistent with the optimum management of Refuge habitat. All control

methods will be accomplished by the most humane manner and in accordance with Service directives.

Incidental control and selective trapping of feral animals are authorized under the Refuge Manual, 7 RM 14.7E. In addition, animals without ownership that have reverted to the wild from a domestic state (i.e. feral hogs) may be taken by authorized Federal or State law or regulations as outlined by title 50 CFR (Code of Federal Regulations), Part 30, Section 11. Authorization of control practices are further governed by title 50 CFR, Part 31, Section 14: (a) Animal species which are surplus or detrimental to the management program(s) of a Wildlife Refuge area may be taken in accordance with Federal and State laws and regulations by Federal or State personnel or by permit issued to private individuals; (b) Animal species which are damaging or destroying Federal property within a wildlife Refuge area may be taken or destroyed by Federal personnel. Disposition of feral hogs is covered under title 50 CFR, Part 30, Section 12: Feral animals taken on wildlife refuges may be disposed of by sale on the open market, gift or loan to public or private institutions for specific purposes, and as otherwise provided in section 401 of the act to June 15, 1935 (49 Stat. 383, 16 U.S.C. 715s). The authority to allow harvest of feral hogs on Refuge lands is governed under the provisions of the regulations for hunting on wildlife refuges title 50 CFR, Part 32.

#### **IV MANAGEMENT GOALS**

Employing an effective control method is essential to accomplishing the goal of eradication or drastic reduction in feral hog numbers (USFWS 1996). As previously stated, feral hogs are the most prolific large mammal in North America and given adequate nutrition, a feral hog population can double in four months (Barrett and Birmingham 1994). For a control method to be successful, 70 percent of the population must be removed annually in order to exceed recruitment within the herd and effect control within 9 years; 70 percent must be removed twice a year to effect control in three years (USFWS 1996).

#### **V MANAGEMENT OPTIONS**

Current research has demonstrated that effective control of feral hog populations is possible, but requires a combination of lethal control measures. Aerial hunting with helicopters, cage traps, foot and neck snares, and hunting with dogs are the most effective control measures when used in combination. The selected control method for a particular habitat type depends on the (1) pig population density, (2) terrain and vegetation, (3) distance from Refuge infrastructure, (4) the potential level of public participation, (5) available access roads and (6) proximity to human population centers. To evaluate each control method, a number of questions must be asked. Is the method:

1. effective in removing a large number of pigs in a short amount of time with minimal effort;
2. reasonable from a cost benefit standpoint;
3. relatively humane, recognizing that any technique involves some measure of trauma, pain and suffering to the animal sought;
4. safe to humans who employ it and non-impacting on non-target animals and the habitat
5. legal and in compliance with Federal, State and County laws, rules, regulations, policies and standards? (USFWS 1996)

### 5.1 *Physical or Mechanical Barriers*

Fencing with hog wire which has graduated mesh size from smaller on the bottom to larger on the top would be erected to keep feral hogs from occupying each fenced management unit. All feral hogs in the enclosed management units could potentially be eliminated via public hunting combined with intensive staff trapping and hunting effort. This method is used with great success in both Hawaii and Australia and constitutes the primary control method. However, in the U.S., this control method is generally considered to be the most expensive and least effective control method for feral hogs, as this tactic seldom provides permanent control because feral hogs can find their way through just about any type of fence (Stevens 1996). Furthermore, because of the widespread damage caused by feral hogs, the areas are too large to effectively protect solely with physical or mechanical barriers (USFWS 2000). In addition, the construction of several large fenced management units throughout the Refuge would severely restrict wildlife movement (which is of no concern to the island of Hawaii as the only native mammal to the island is a small bat). This could possibly result in fragmented populations and pose entanglement problems.

### 5.2 *Public Hunting*

Public hunting is most often not considered a valid control method or management tool. This method is sometimes utilized on NWR s as a means to appease the public and allow for recreation. This method has been attempted as a means to reduce feral hog numbers on Havasu NWR back in 1975 but resulted in a low hunter success rate and high administrative costs (USFWS 1979). Most public hunters will not hunt far from road accesses and hunter effort tails off as success declines. In addition, several places that do allow hunting are finding that hunters do not support the goal of eliminating the feral hogs. They feel instead that hog populations should be maintained at low to medium levels by a permanent feral hog hunting program, which is not a refuge objective.

### 5.3 *Contract Removal Experts*

This control method is generally considered a useful management tool in terms of success in controlling feral hogs. Professional removal experts may be sought by Refuge management to remove specific hogs or large numbers. In their 1994 Feral Hog Management Plan, Hakalau Forest NWR wrote that, The key to use of professional hunters is writing and enforcing contract

conditions which clearly specify time frames, methods, precautions, disposition of meat and record keeping .

#### *5.4 Interagency Agreement with Wildlife Services*

This method would entail contracting a professional hog hunter/trapper through Wildlife Services (WS) that would practice feral hog control on Refuge property for a period of time to be established by Refuge management. This contracted individual would utilize an Integrated Pest Management Approach to feral hog control. This may involve the use of hunting with dogs, construction and use of box or corral traps, and sweeping the area with both neck and leg snares. This approach may also entail aerial hunting of hogs on the marsh beginning in late January/early February. All hogs would be shot on site and left in the brush for scavengers until alternative means to utilize the meat are found.

This alternative would require minimal Refuge supervision as WS is well known for their expertise in nuisance animal control. The contracted agent would have the knowledge and ability to apply a series of control measures while also ensuring greater hog population declines in a shorter period of time.

This method is relatively expensive and would require a significant increase in the Refuge budget.

## **VI MANAGEMENT PLAN**

### *6.1 Fencing*

In addition to the plan to be initiated by the contracted WS agent, it is possible for the 4 miles of fencing that encircle the Pintail Slough Management Area be repaired and integrated into the overall management plan. This area currently consists of 130 acres of croplands, 140 acres of desert upland and 165 acres of wetland habitat. This location would be ideal for the WS agent to run his hunting dogs and place as many corral or box type traps due to its relative openness and accessibility.

### *6.2 Cage and Corral Traps*

Advantages to this method include its species selectivity and the potential for multiple catches at one setting. Cage traps should be placed in areas of recent hog activity and be baited with whatever is needed to lure the hogs into the trap. Disadvantages of cage traps are the cost of construction and the difficulty in moving traps from one location to another. These traps are difficult to conceal, are more likely to be avoided by hogs, and may attract the unwanted attention of humans.

This method will only be effective at times when food is relatively scarce and stress levels of the hogs are high. For this region of the country, food scarcity and high stress levels occur during the extreme temperatures of the hot summer months. Attempts of baiting hogs into a portable box trap during the fall and winter months were unsuccessful. This is most likely due to the abundant mesquite seed crop. For the desert region, it would be necessary to focus cage trapping during the hot summer months.

### *6.3 Neck and Leg Snares*

Neck snares are a useful tool for controlling feral pigs, however, extreme care must be taken when setting them to avoid catching non-target animals (USDA). Foot and neck snares are inexpensive, extremely portable, and easy to conceal. They can be set in trails or other locations where pigs travel. Snares should be set approximately 2-6 inches off the ground with about an 18-inch loop; the snare must be anchored securely to a tree of at least 4 inches in diameter (USDA). If properly set, snares remain active in all weather conditions and can capture and hold even the largest hog. Disadvantages to this method are that the snare cables have to be replaced after every capture, only one capture is possible at a time, the snares must be checked daily, and non-target species may be caught.

### *6.4 Organized Hunts*

Hunting over bait piles, spotlight shooting, night vision shooting, and calling, are examples of, but not limited to, organized hunts (USDA). These methods are not expensive to try, but may not always be effective. This method is very labor intensive in terms of organizing and running.

### *6.5 Aerial Hunting*

Aerial hunting involves shooting hogs from a fixed wing aircraft or helicopter (Littauer). This method requires an experienced pilot and capable gunner. A ground crew of several individuals walking or hunting with dogs through the area can enhance success (Littauer). Advantages to aerial hunting are its high selectivity since only target animals are taken, a depredation or damage problem can be stopped in a short period of time and large numbers of hogs can be taken in a short period of time. Disadvantages include the high cost for helicopter rentals, its ineffectiveness in areas with heavy cover, the hazards involved when flying in rugged topography, and being weather dependent. Due to the thick vegetation that encompasses Topock Marsh, aerial hunting would have to be conducted at a time when the needles have shed off their branches in the fall/winter to increase visibility. Therefore, this method of control would be more effective in late January and early February.

### *6.6 Opportunistic Take by Authorized Government Employees*

This method will be used when authorized government employees happen upon a hog and can take the animal in an easy and safe circumstance.



### *6.7 Contract Removal Experts*

Experts may be sought by Refuge management to remove specific animals. These experts may include the Wildlife Services (WS) division of the U.S. Department of Agriculture (USDA), local hunters, and trappers. Methods used by these contractors must be approved by Refuge management prior to use. The Refuge reserves the right to conduct background investigations on any potential trapper (USFWS 2000). All feral hogs captured under the permit become the property of the permittee upon leaving the Refuge. It will be required that all hogs caught are dead prior to leaving Refuge property. All permittees will be required to submit monthly progress reports that include information on numbers and descriptions of feral hogs.

## **VII RESTRICTIONS AND STIPULATIONS**

- 1.) No hunting in the South-western willow flycatcher (WIFL) habitat during breeding season:  
April 15 - September 1. See map of WIFL habitat (Figure 2).
- 2.) No making trails or cutting vegetation of any kind in WIFL habitat.
- 3.) All snares and traps **MUST** be checked daily.
- 4.) All non-target wildlife **MUST** be released unharmed.
- 5.) Contracted agent **MUST** provide monthly progress reports to Refuge manager.
- 6.) It is not recommended for WS agent to run hunting dogs in areas where foot and neck snares are placed to prevent unnecessary death or injury to hunting dogs.

# Topock Marsh- WIFL Habitat

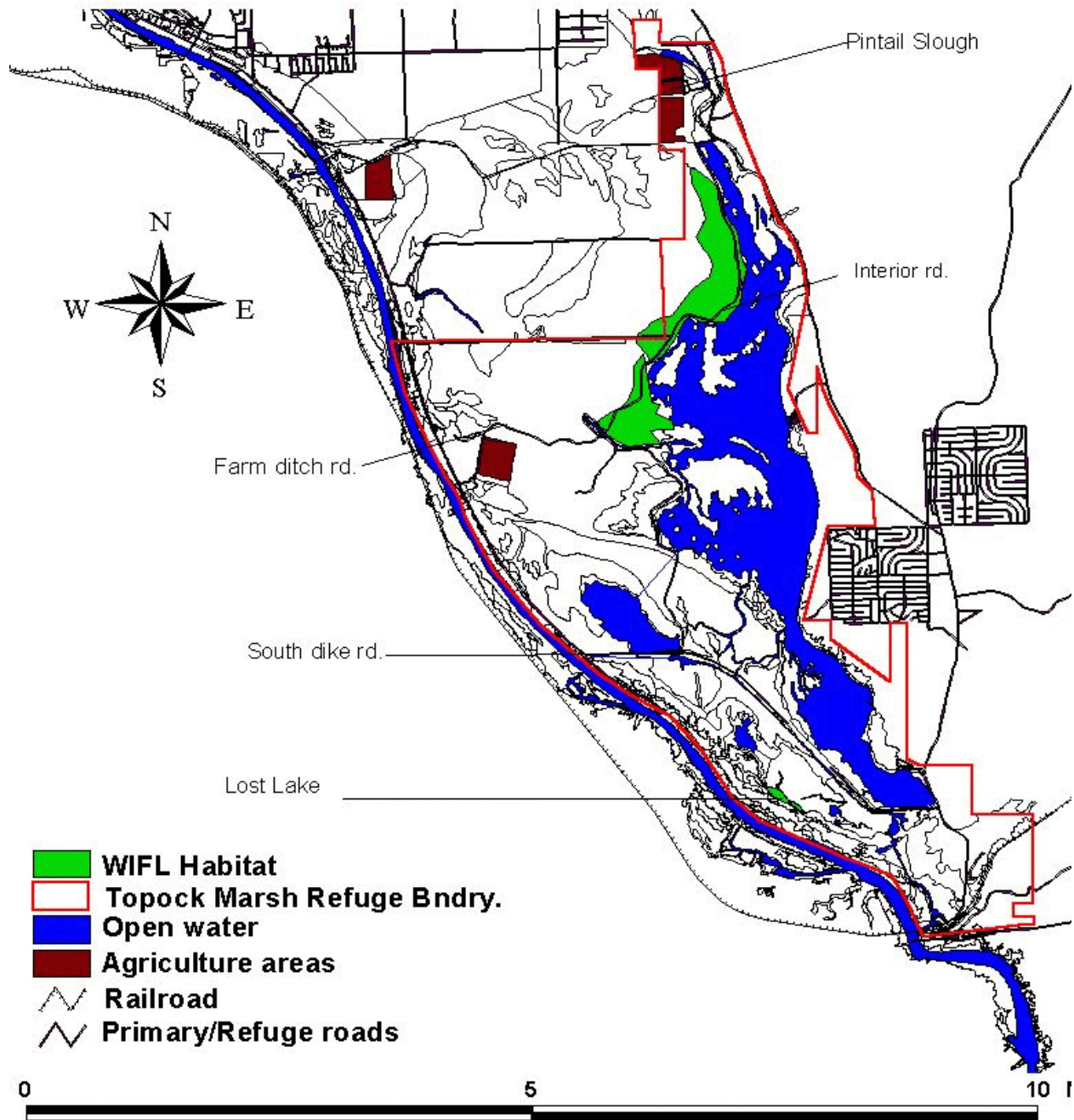


Figure 2. Map of WIFL Habitat.

## VIII MONITORING

Monitoring the number of feral hogs, their distribution and impacts on the habitats of native plants and animals should become an integral part of the Feral Hog Management Plan. Measuring hog activity levels on the Refuge is necessary for evaluating the damage caused to the habitat and the success of control methods (USFWS 1996). Three points are important when implementing resource and threat monitoring:

1. The program should be designed and funded as an ongoing, long-term project.
2. A regional approach to monitoring can cut costs and yield better data.
3. A team of monitoring experts improves the reliability of data and reduces overall program costs (Dunn 1992).

The following, which describes methodology for monitoring feral hogs, is excerpted from: *Long-Term Biological Resource and Threat Monitoring of Hawaiian Natural Areas* by Patrick Dunn of The Nature Conservancy of Hawaii for Hawaii Department of Land and Natural Resources Division of Forestry and Wildlife Dec. of 1992)

Ungulate activity is measured along permanent belt transects at least 500 m long. Sign of ungulate activity is evaluated as to its age (fresh or old) within contiguous 5 m-wide by 10 m-long stations. The presence and age of activity or, optionally, the percentage of the station covered with activity is recorded. Normally, ungulate activity is monitored 3 times per year.

There are 3 basic categories of ungulate activity data: 1. Mean activity throughout the Refuge or management unit, 2. Worst-case activity along transects placed in hot-spots and 3. Activity within sensitive resource areas. The fundamental analysis of activity data is a time series of mean activity levels.

NOTE: The complete protocol for monitoring feral hogs is included in the appendix.

This monitoring technique is now employed by the Hakalau Forest NWR in Hawaii and by other natural resource agencies including the National Park Service, the State of Hawaii Natural Area Reserve System and The Nature Conservancy of Hawaii (USFWS 1996 and Dunn 1992). This technique meets most of the objectives of monitoring and provides relatively accurate and usable data. It is an indirect method and does not provide complete information on feral hog distribution and density. Therefore, supplemental means of monitoring include incidental observations of feral hog and vegetation by Refuge staff during the course of other duties, necropsies of hogs to determine reproductive status and food habits, reports by contracted individuals on the Refuge, and by the establishment of photo stations and photo plots (USFWS 1996).

## **IX FUTURE REVISIONS**

As new research, technologies, and techniques become available, they may be incorporated into the existing management plan in the form of amendments.

## LITERATURE CITED

- Barrett, R.H. and G. H. Birmingham. 1994. Wild Pigs. pp. D 65-70 in G.E. Larson et.al, ed. Prevention and Control of Wildlife Damage. Great plains Agriculture and Natural Resources Division. University of Nebraska, Lincoln.
- Barrett, R.H., B.L. Goatcher, P.J. Gogan, and E.L. Barrett, R.H., B.L. Goatcher, P.J. Gogan, and E.L. F. Annadel State Park. Trans. Western Sect. Wildl. Soc. 24:47-52.
- Bird Checklist of the United States- Havasu National Wildlife Refuge. USGS Northern Prairie Wildlife Research Center. 22 April 1999  
<http://159.189.96.215/resource/othrdata/chekbird/r2/havasu.htm>
- Bratton, S.P. \_\_\_\_\_. Wild Hogs in the US. - Origin and Nomenclature.
- Burns, R. and Loven, J. Feral Hogs Causing Increased Damage to Croplands, Wildlife Habitat Texas Animal Damage Control Service. Pp. 139-147.
- Coblentz, B.E. and D.W. Baber. 1997. Biology and Control of Feral Pigs on Coblentz, B.E. and Galapagos, Ecuador. J. Appl. Ecology 24:403-418.
- Davis, D.E. Ph.D. (ed). CRC Handbook of Census Methods for Terrestrial Vertebrates. Boca Raton (FL): CRC Press Inc.
- Dunn, P. 1992. Long Term Biological Resource and Threat Monitoring of Hawaiian Natural Resources. Hawaii Department of Land and Natural Resources Division of Forestry and Wildlife.
- Guay, B. 2001. Preliminary Hydrologic Investigation of Topock Marsh, Arizona 1995-1998. U.S. Fish and Wildlife Service Technical Report. U.S. Fish and Wildlife Service Technical Report. U.S. Fish and Wildlife Service at Havasu NWR Needles, CA.
- Gipson, P.S., D.P. Jones, J. C. Luchsinger and C.D. Jones. 1999. Established Feral Pig Population in Kansas. Proc. East. Wild. Damage Mgt. Conf. 103.
- Littauer, G.A. Control Techniques for Feral Hogs. Texas Animal Damage Control Service Document pp. 139-137. Unpublished Report.
- McIlroy, J.C., M. Braysher, and G.R. Saunders. 1989. Effectiveness of Warfarin-poisoning campaign against Feral Pigs, *Sus scrofa*, in Namadgi National Park. Wildlife Management 16:195-202.

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- U.S. Fish and Wildlife Service. 1996b. Environmental Assessment for Wildlife Refuge Feral Ungulate Management Plan. U.S. Department of the Interior. Honolulu, Hawaii.
- U.S. Fish and Wildlife Service. 1999. Proposed Beal Lake Improvement Assessment. Prepared by M. Connolly. U.S. Department of the Interior. On file at Havasu NWR Needles, CA.
- U.S. Fish and Wildlife Service. 2000a. Feral Hog Management Plan and Compatibility Determination Unpublished Plan. U.S. Department of the Interior. On file at Havasu NWR Needles, CA.
- U.S. Fish and Wildlife Service. 2000b. Environmental Assessment of Lower Rio Grande Complex. Unpublished Plan. U.S. Department of the Interior. On file at Havasu NWR Needles, CA.
- U.S. Fish and Wildlife Service. 2000. Merritt Island National Wildlife Refuge Contract. Unpublished Contract. U.S. Department of the Interior. On file at Havasu NWR Needles, CA.
- U.S. Fish and Wildlife Service. Feral Hog Control Proposal at Laguna Atascosa NWR. Unpublished Report. U.S. Department of the Interior.
- Wood, G.W. and R.H. Wood, G.W. and R.H. Barrett. 1979. Status of Wild Pigs in the U.S. Wildlife Bulletin 7:237-246
- U.S. Fish and Wildlife Service. Proposal for Controlling Feral Hogs at Satellite Areas. Unpublished Report. U.S. Department of the Interior. On file at Havasu NWR Needles, CA.
- WRCC. 1997. Western Regional Climate Center. [www.wrcc.dri.edu/index.htm](http://www.wrcc.dri.edu/index.htm).